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PUBLIC-PRIVATE COLLABORATIONS WITH EARTH-SPACE BENEFITS

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The NASA Human Health and Performance Center (NHHPC) was established in October 2010 to promote collaborative problem solving and project development to advance human health and performance innovations benefiting life in space and on Earth. The NHHPC, which now boasts over 150 corporate, government, academic and non-profit members, has convened four successful workshops and engaged in multiple collaborative projects. The virtual center facilitates member engagement through a variety of vehicles, including annual in-person workshops, webcasts, quarterly electronic newsletters, web postings, and the new system for partner engagement. NHHPC workshops serve to bring member organizations together to share best practices, discuss common goals, and facilitate development of the collaborative projects. The most recent NHHPC workshop was conducted in November 2013 on the topic of “Accelerating Innovation: New Organizational Business Models,” and focused on various collaborative approaches successfully used by organizations to achieve their goals. Past workshops have addressed smart media and health applications, connecting through collaboration, microbiology innovations, and strategies and best practices in open innovation. A fifth workshop in Houston, Texas, planned for September 18, 2014, will feature “Innovation Through Co-Development: Engaging Partners”.

One area of great interest to NASA is mobile health applications, including mobile laboratory analytics, health monitoring, and close loop sensing, all of which also offer ground-based health applications for remote and underserved areas. Another project being coordinated by NASA and the Health and Environmental Sciences Institute is the pursuit of one to several novel strategies to increase medication stability that would enable health care in remote terrestrial settings as well as during space flight. NASA has also funded work with corporate NHHPC partner GE, seeking to develop ultrasound methodologies that will enable NASA to further understand the eye changes related to long-duration space flight. The adaptation of ultrasound to this type of eye examination could also expand the use of ultrasound in health care on the Earth in settings where MRIs are not available.

To further engage NHHPC members and facilitate partnership development for NASA, the NHHPC created and deployed an engagement system in 2014 that facilitates identification and evaluation of technical needs and opportunities among all NHHPC members.

I. INTRODUCTION

In 2005 the Space Life Sciences Directorate (SLSD) to experienced a 45% reduction in its research and technology budget. These reductions led the SLSD to conduct a visioning exercise that led to the 2007 strategy. This 2007 strategy was designed to build resilience into the organization by focusing on collaborative approaches to problem solving and in developing a comprehensive risk management system. This risk management system enabled the SLSD to clearly articulate a portfolio of research and technology efforts aimed at mitigating the highest priority human

health and performance risks for space flight. A subsequent reorganization led the SLSD to emphasize products in clinical medicine and operations, biomedical and environmental research and human system engineering and hardware development and the SLSD was renamed the Human Health and Performance Directorate (HH&P). Today, this mature risk management process permits the HH&P to address a variety of current and future space flight missions from 6 to 12 month flights on the International Space Station (ISS), a deep space asteroid redirect mission (ARM) and future planetary missions to Mars.

Since 2009, the NASA Space Life Sciences, now the Human Health and Performance (HH&P) Directorate expanded the pursuit of public-private partnerships and the use of open innovation competitions to seek solutions to some of the more difficult and pressing human health risks in space flight. In 2010, NASA established the NASA Human Health and Performance Center (NHHPC) to exchange best practices and to facilitate partnership development across sectors for solving medical, environmental, and human performance problems in space and on Earth. The NHHPC now has over 150 members with several collaborative projects in work including a medication stability project and one addressing the biology of stress each with collaborative partners external to NASA.

II. DEVELOPMENT OF PARTNERSHIPS

Portfolio Management

Beginning in 2004, the Space Life Sciences Directorate, now the Human Health and Performance Directorate (HH&P), initiated development of standards for health care inflight, standards that had not previously existed. The standard development began at the request of the biomedical research manager at NASA Headquarters (HQ) to better focus the research and technology portfolio to the key human health and performance risks for space flight. This focus became even more important after 2005, when the research and technology budget was reduced 45%. After that reduction and with guidance from the standards in development, the Human Research Program was developed with content and budget remarkably stable to this day.

The standards were developed in two volume sets. The first was entitled Space Flight Human System Standard (SFHSS) 3001, volume 1 Human Health. These standards focused on key parameters of human health in space flight including bone and muscle loss, cardiovascular fitness, and radiation exposure. A second set of standards, SFHSS volume 2, Human Factors and Habitability, provide guidance for space craft design for the human system. Both standard sets serve as the basis for the development of focused risk identification and mitigation. An informational volume, the Human Integration Design Handbook (HIDH), captures many decades of experience from HH&P experts and serves as guidance to future space craft developers.

In parallel, a novel risk management analysis tool (RMAT) was developed to capture all of the knowledge and technical information about a risk, beginning with the existing standard to analysis of specific missions

(design reference missions) to the set of deliverables (research, operations, technology) to mitigate the risk. Today, this mature system tracks 30 risks and 2 concerns that are evaluated through the Human System Risk Board (HSRB). The HSRB is a multi-disciplinary board that analyzes whether the right work is being performed for a specific mission, if milestones for deliverables are being met, and integrates all available operational and research information to mitigate a particular risk. The HSRB also recommends whether novel approaches to problem solving such as forming collaborative partnerships or open innovation competitions should be considered. Risk owners may then utilize the NHHPC to seek external partners for deliverables for a particular risk and mission. The HH&P is now actively posting its technical needs through the NHHPC and external partners may suggest approaches that meet these needs through an active partner engagement process.

Engagement

In October 2010, the SLSD realized a primary objective of the 2007 Strategy by establishing the NASA Human Health and Performance Center (NHHPC), which now has over 150 member organizations. The NHHPC was created to provide a convening forum for all member organizations interested in advancing human health and performance innovations, to collect and disseminate best practices, and to facilitate the development of collaborative projects among members.

NASA has conducted four workshops for NHHPC members, with a fifth planned for September 2014. The November 2013 workshop focused on accelerating innovation through new organizational business models, and one keynote speaker, Bill Eggers, described successful cross-sector problem solving in his new book, *The Solution Revolution*. An earlier workshop featured the US Chief Technology Officer (CTO) Todd Park who addressed innovations in mobile applications to advance understanding of health care data. Additional products provided by the NHHPC include the Innovation Lecture Series (ILS), which features expert speakers in person and via webcast for member organizations four times per year, a quarterly electronic newsletter publicizing member accomplishments and interests, and a facilitated process for posting and responding to member organization needs and proposals. A fifth workshop, conducted in conjunction with the Houston Technology Center, will again bring together NHHPC member organizations from around the world to address “Innovation through Co-development: Engaging Partners” in Houston, Texas on September 18, 2014.

In 2014, NHHPC is created and deployed an engagement process that facilitates the evaluation of opportunities from multiple points of intake through a common format on the NHHPC website. After an initial screen by the engagement team, project opportunities for evaluation are assigned to appropriate managers and subject matter experts to recommend whether to pursue the opportunity. The result is an end-to-end electronic process that spans identification of a potential opportunity, to selecting the most effective tool to implement a project, to seeking partners. All current and archived projects can be tracked and reviewed to facilitate partner engagement and collaboration.

The value of the engagement process has already been demonstrated in evaluating numerous co-development projects that were brought into NASA by the Strategic Opportunities and Partnerships Development (SOPD) directorate. The SOPD put out a call to the external community, seeking partners in key technical areas, and the HH&P utilized the NHHPC engagement process to evaluate the projects. At present, at least six opportunities submitted by external partners are under evaluation and the respective companies may be invited to present to NASA personnel for further evaluation. Proposals that have been received include novel medical diagnostic and therapeutic technologies, novel approaches to microbiological sampling and testing, and food packaging. Proposals have also been received from international organizations highlighting the collaborative potential of the NHHPC.

The NHHPC forum also provides a platform for international partners to interact on many topics. NHHPC members Wyle, NASA and the German Aerospace Center (DLR) joined together to conduct two day-long global networking forums addressing “Collaborative Innovation: Strategy to Results,” and “Improving the Quality of Life on Earth – Societal Impacts of Human Space Flight” at the 2011 and 2012 [International Astronautical Congresses](#) (IAC).¹ Many International Space Station (ISS) and other international partners participated such as the Canadian Space Agency, DLR, European Space Agency, IBMP Russian Academy of Sciences, Japanese Space Agency, and NASA. At the 2012 IAC meeting, an NHHPC plenary session featured executives from six space agencies who discussed successful partnerships that resulted in technologies with benefits to human space flight and life on Earth.

Other NHHPC international engagement efforts include on-going workshop development with the :envihab medical research facility of the Institute of

Aerospace Medicine of DLR and conference participation with the World Biomimetic Foundation to address innovation inspired by nature in Barcelona, Spain in 2014.¹ Two UK workshops featured best practices exchange at the Open Innovation Workshop in Space Medicine at the International Space Innovation Centre in Harwell, England and the UK Space Biomedicine Consortium Meeting in Aberdeen, Scotland in 2012. As a direct result of the fourth NHHPC workshop in November 2013, a US-UK workshop was conducted June 25, 2014 that facilitated discussions among NASA, Wyle, Satellite Applications Catapult, the new Space Life Sciences Innovation Centre at the Edinburgh BioQuarter, the Rice University Space Institute, National Space Biomedical Research Institute (NSBRI), and others to facilitate US-UK collaboration and technology development.

III. COLLABORATIVE PROJECTS

The NHHPC has facilitated several collaborative projects among members through convening workshops and an active partner engagement process. A medication stability project is in development with NASA and the Health and Environmental Sciences Institute (HESI) in Washington DC. HESI is a non-profit that serves as a platform for cross-sector, cross-discipline collaboration between any groups interested in conducting quality science to improve human or environmental health.¹ HESI is located in DC but works globally with public and private sector scientists working together. Common ground on projects can often be found in the pre-competitive space that is where HESI operates e.g. health, safety, and sustainability and risk assessment.

The medication stability project envisions development of several novel technologies to enhance medication stability for the benefit of space flight as well as terrestrial health care. A pilot project is being discussed to find a pathfinder medication that in which several public and private entities could participate in the pre-competitive space by setting requirements and enhancing scientific knowledge. A second competitive process could then follow whereby specific technologies are sought. Today, a NASA mission over one year in length would exceed current the shelf life of many medications and a path forward to extend shelf life is being sought. This general approach could have a significant impact on terrestrial health care as well.

Initial discussions are underway with the Veterans Administration Center for Innovation for collaborative projects of mutual interest. Discussions have also been held with the Department of Defense Information Analysis Centers (IAC) to find government applications

from commercial development and to find ways to scale some of the successful early innovation pilot projects within the government.

NASA has signed Space Act Agreements with multiple corporate NHHPC partners including GE, Philips, and Nike, and is pursuing projects that meet the missions of NASA and the partner organizations.¹ The GE collaboration seeks to develop ultrasound to examine the eye during space flight that will enable NASA to further understand eye changes related to long-duration space flight. If successful, this ultrasound project could then expand the use of ultrasound in eye exams on earth in settings where other imaging technologies cannot be deployed.

NASA is pursuing several technologies using mobile health platforms that may provide inexpensive, portable, and integrated solutions for onboard ISS analysis. If successful, these technologies may be commercially developed and provide ground-based health applications. While direct access to healthcare may be severely limited in some areas, use of mobile phones is widespread, and can be leveraged to monitor or diagnosis disease and to interface with physicians (e.g., blood glucose, HIV, malaria analysis). One example is an “Ophthalmologist-in-a-Phone” mobile health application developed by NETRA at the Massachusetts Institute for Technology Media Lab that can perform eye refraction exams as a portable cell phone attachment.^{1,2}

The NASA HH&P Directorate is utilizing the NHHPC in 2014 to convene a workshop of experts in the development, integration and management of large data systems. The HH&P manages a complex human and environmental health data system that needs to be optimally managed and integrated to facilitate human health risk reduction for space flight. The data architecture system workshop is planned for September 17, 2014 to permit attendees to attend the NHHPC workshop on September 18 on co-development. Convening technical workshops in this way permits the interaction of cross-sector organizations that may develop recommendations for the benefit of all participants.

NHHPC projects may also focus on collaborative research. NASA and the National Science Foundation (NSF) are currently proposing a joint study on the biology of stress using an accelerated research model called Ideas Lab¹. Ideas Lab is a facilitated approach developed by the NSF based on the United Kingdom Sandpit model, which combines multiple research

disciplines around a single topic and generates creative research proposals in a rapidly iterative process. NASA and the NSF conducted an exploratory workshop in December 2013 to develop topics of mutual interest addressing stress biology, and are currently assessing the outcomes and developing next steps for a joint Ideas Lab.

IV. PRIZES WITH EARTH/SPACE BENEFITS

Prize-based pilots were initiated in 2008 and now continue to this day for the “Earth/Space Life Science” prize that the HH&P offers through the annual Rice Business Plan Competition (RBPC) at Rice University. The RBPC is conducted each spring among 42 teams of students (with MBA and technical members) selected to compete, and the NASA life sciences prize is awarded to the team with a technology that has commercial promise as well as application to human space flight. One team, Glucago (now LyoGo), was selected by in 2010 and has now received series A funding. More recent winners such as BriteSeed (2013) and Tympanogen (2014) are being followed as possible flight projects.

V. CONCLUSION

The business model for the NASA Human Health and Performance (HH&P) Directorate now actively incorporates the use of collaborative public-private partnerships and the use of prizes with earth/space benefits that have resulted in significant advances in achieving NASA’s human health and performance risk mitigation goals. The establishment of virtual partnership centers, such as the NHHPC, has greatly facilitated project development among public-private partners and the rapid sharing of best practices and results for the benefit of all.

VI. REFERENCES

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